APPENDIX: INVESTMENT IN DISADVANTAGED COMMUNITIES

James K. Boyce

This appendix discusses issues related to investment in disadvantaged communities, including localities that are disproportionately impacted by co-pollutants associated with use of fossil fuels.[1]

AB 32 provisions

Section 38565 of the California Global Warming Solutions Act of 2006 (AB 32) mandates that CARB should seek to channel investment to the state's most disadvantaged communities:

> *The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions.*

In addition, section 38570(b) mandates that the California Air Resources Board (CARB) should consider localized impacts of co-pollutants:

> *Prior to the inclusion of any market-based compliance mechanism in the regulations, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall to all of the following: (1) Consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution. (2) Design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants.*

As documented below, disadvantaged communities often are disproportionately impacted by air pollutants, including co-pollutants generated by the use of fossil fuels. One way to respond to these mandates is to allocate a share of allowance value to such communities for the purpose of environmental improvements.

This use of allowance value primarily involves investment, but it also can be categorized as "compensation" in that a community's eligibility to receive benefits rests on its disadvantaged status including disproportionate pollution exposure. However, this differs

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[1] This is a revised version of the author's EAAC memorandum of the same title, dated October 7, 2009.

fundamentally from other types of compensation that rest on claims of losses *relative to the status quo ante* prior to AB 32 implementation. The case for compensation to localities rests instead on disadvantages that antedate AB 32. That is, eligibility for compensation does not require that AB 32 causes an increase in co-pollutants in the localities – an outcome specifically prohibited in section 38570(b), quoted above – but rather that disproportionate impacts *relative to other localities* persist after AB 32 implementation. Again unlike other types of compensation, the aim in this instance is not to "make the recipient whole" but rather to mitigate gaps in environmental and economic well-being in disadvantaged localities relative to statewide norms.

General considerations

Co-pollutants and the co-benefits from their reduction are relevant to the efficiency, environmental, and fairness objectives of AB 32.

Efficiency considerations

The efficiency objective implies that policy should seek to maximize net social benefits from reducing greenhouse gas emissions. These benefits include co-pollutant reductions. To ignore them would be tantamount to leaving health-care dollars lying on the ground.

From a climate-change standpoint, the marginal benefit of carbon reductions is constant across emission sources. But in the presence of co-pollutants – such as particulate matter, NOx, and air toxics released by the burning of fossil fuels – the marginal benefit can and does vary across emission sources.

As is well-known, variations in marginal abatement costs across pollution sources provide the static-efficiency rationale for using market-based incentives (such as cap-and-trade), as opposed relying exclusively on regulatory standards to achieve pollution-control objectives. The aim is to achieve pollution reductions at least total cost.

Variations in marginal abatement benefits complicate the picture, however. These variations provide a rationale for greater pollution reductions (and higher marginal abatement costs) for some emission sources than for others.

Muller *et al.* (2009) estimate that on average, the co-benefits from co-pollutant reductions due to a nationwide cap on carbon emissions will be on the same order of magnitude as the benefits from carbon emissions reduction itself.[2] In a study of the co-benefits of

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[2] Nicholas Z. Muller, Britt Groosman and Erin O'Neill-Toy, "The ancillary benefits of greenhouse gas abatement in the United States." Forthcoming, 2009. See http://college.usc.edu/geography/ESPE/documents/Muller_USC_6_30_09.pdf.

carbon emission reductions in the European Union, Berk *et al.* (2006) reach similar conclusions.[3]

A 2009 study by the National Academy of Sciences estimates that the burning of fossil fuels in the United States is responsible for roughly 20,000 premature deaths each year, translating into $120 billion/year in health damages.[4] This estimate is based on the effects of criteria air pollutants, and does not include damages from climate change, harm to ecosystems, or other air pollutants such as mercury.

In addition to improvements in the quantity and quality of life, benefits from co-pollutant reductions include health-care cost savings, reductions in days lost from work due to illness and the need to care for ill children and other dependents, and gains in property values.

In economic terms, the co-benefits from co-pollutant reduction add to the benefits from reduced carbon-dioxide emissions. This justifies greater reductions (tighter caps, higher permit prices, and higher marginal abatement costs) than would be warranted in the absence of co-benefits.

If co-pollutant intensity, here defined as the ratio of co-pollutant damages to carbon-dioxide emissions, were a fixed coefficient, there would be no efficiency case for modifying policy design (beyond adjusting the cap) to take co-pollutants into account. But there are strong *a priori* reasons to expect that co-pollutant intensity varies across regions, sectors and polluters. Empirical evidence supports this view.

The ratio of co-pollutant emissions to carbon-dioxide emissions varies depending on the fuel source (higher for coal, lower for natural gas, in-between for oil) and on pollution control technologies. In addition, damages per unit of co-pollutant emissions vary depending, among other things, on stack heights, population densities, and total exposure (the marginal damage function is usually assumed to be convex, with marginal damage increasing in total exposure).

These variations are illustrated in Figure 1, which shows co-pollutant intensity for air toxics releases reported in the USEPA's Toxics Release Inventory (TRI) from three industrial sectors: petroleum refineries, cement manufacturing, and power plants. Panel (a) shows total mass of releases (kilograms) of the roughly 600 chemicals in the TRI database per ton of carbon-dioxide emissions. By this measure, petroleum refineries have
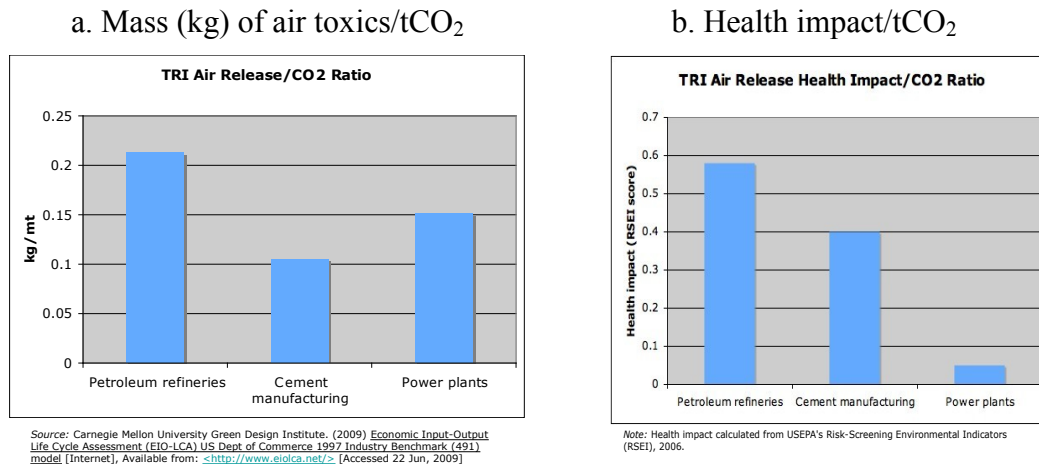
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[3] M.M. Berk *et al,* "Sustainable energy: Trade-offs and synergies between energy security, competitiveness, and environment." Bilthoven: Netherlands Environmental Assessment Agency (MNP), 2006.

[4] National Academy of Sciences, Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption, National Research Council (2009) *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* See press release at http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12794.

roughly twice the co-pollutant intensity of cement manufacturing facilities, with power plants lying between the two. Panel (b) shows the relative human health impacts of these same releases, taking into account stack heights, toxicities, the fate-and-transport of chemicals in the environment, and population densities. Petroleum refineries again score highest by this measure, but power plants score below cement manufacturing.

Figure 1: Intersectoral variations in co-pollutant intensity
(air toxics/ton CO_2)

a. Mass (kg) of air toxics/tCO_2

b. Health impact/tCO_2

Source: Carnegie Mellon University Green Design Institute. (2009) Economic Input-Output Life Cycle Assessment (EIO-LCA) US Dept of Commerce 1997 Industry Benchmark (491) model [Internet], Available from: <http://www.eiolca.net/> [Accessed 22 Jun, 2009]

Note: Health impact calculated from USEPA's Risk-Screening Environmental Indicators (RSEI), 2006.

From the standpoint of efficiency, the existence of co-pollutants therefore implies not only that the cap on carbon emissions should be tighter than what would be warranted by the environmental impacts of carbon-dioxide alone, but also that policy design should respond to variations in co-pollution intensity.

Environmental considerations

The environmental objective refers to the full range of pollution-reduction benefits that AB 32 implementation can bring about. Section 38501(h) of AB 32 explicitly set forth this objective:

> *It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established pursuant to this division in a manner that minimizes costs and maximizes benefits for California's economy, improves and modernizes California's energy infrastructure and maintains electric system reliability, maximizes additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality.*

Among possible uses of revenue generated under AB 32, CARB's December 2008 Scoping Plan includes:

> *Achieving environmental co-benefits* – *Criteria and toxic air pollutants create health risks, and some communities bear a disproportionate burden from air pollution. Revenues could be used to enhance greenhouse gas emission reductions that also provide reductions in air and other pollutants that affect public health.*[5]

Air pollution is generated by a variety of sources, not all of them related to fossil fuels. Examples of other sources include solvent evaporation, waste disposal, and (in the case of particulate matter) windblown dust. The production and use of fossil fuels account for a substantial share of emissions of many important pollutants.

Table 1 presents data on fossil-fuel related emissions of reactive organic gases and four criteria air pollutants as a share of total statewide emissions. The contribution of fossil fuels ranges from 41% in the case of fine particulate matter to 96% in the case of nitrogen oxides. The transportation sector (mobile sources) accounts for the major share with the exception of fine particulate matter, where stationary and residential sources contribute slightly more to the total.

Table 1: Percentage share of California emissions derived from production and use of fossil fuels

Pollutants:	ROG	CO	NOX	SOX	PM2.5
Sources:					
Fuel combustion (stationary & residential)	3.8	7.2	10.4	2.9	20.8
Mobile sources	51.2	79.8	85.5	58.9	19.7
Petroleum production & marketing	6.1	0.1	0.3	14.1	0.5
Total	**61.1**	**87.1**	**96.2**	**73.0**	**41.0**

Key: ROG = reactive organic gases   SOX = sulfur oxides
CO = carbon monoxide   PM2.5 = fine particular matter
NOX = nitrogen oxides

Source: CARB, "Almanac Emission Projection Data (Published in 2009)," online at http://www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2008&F_DIV=-4&F_SEASON=A&SP=2009&F_AREA=CA

If, as is commonly assumed, air pollution damages are convex in total exposure – that is, marginal damage per ton of pollution exceeds average damage per ton – then the environmental significance of reductions in co-pollutants as a co-benefit of carbon policy may be even larger than the numbers in the table suggest.

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[5] CARB, *Climate Change Scoping Plan: A Framework for Change.* Pursuant to AB 32, The California Global Warming Solutions Act of 2006, December 2008, p. 70. Online at http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

Fairness considerations

The fairness objective implies that policy should seek to reduce disproportionate pollution in historically overburdened communities. For this reason the issue of co-pollutants has been emphasized by the Environmental Justice Advisory Committee (EJAC).

If co-pollutants were uniformly (or randomly) distributed across the landscape, there would be no fairness reason to design policy to take them into account. But again, both *a priori* reasoning and empirical evidence tell us that they are not uniformly distributed, and that some communities – often lower-income communities – are overburdened by co-pollutants. Figure 2 illustrates this point, showing health risks from air toxics for the same three industrial sectors, relative to the shares of demographic subgroups in the national population. Petroleum refineries have the most disproportionate impact.

Figure 2: Shares of health risk from air toxics
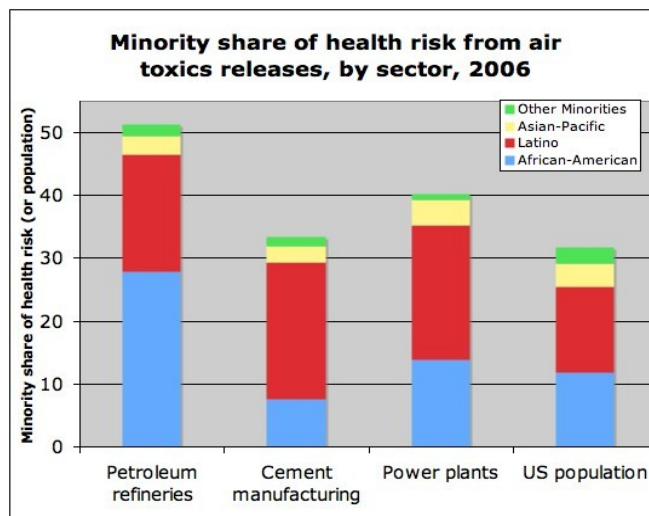
Source: Minority shares of health impact calculated from RSEI-GM data; for methodology, see Ash *et al., Justice in the Air: Tracking Toxic Pollution from America's Industries and Companies to our States, Cities and Neighborhoods,* PERI and PERE, April 2009.

CARB recently resolved "to develop a methodology using available information to assess the potential cumulative air pollution impacts of proposed regulations to implement the Scoping Plan" and "to identify communities already adversely impacted by air pollution as specified in Health and Safety Code section 38750(b)(1) before the adoption of a cap-and-trade program."[6] The resulting information is expected to influence policy design.

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[6] CARB, "Climate Change Scoping Plan, Resolution 08-47," December 11, 2009, p. 8. See also Manuel Pastor, Rachel Morello-Frosch and Jim Sadd, "Environmental Justice Screening Method: Integrating Indicators of Cumulative Impact and Community Vulnerability into Regulatory Decision-making," presented at CARB Informational Board Workshop on Policy Tools for the AB 32 Scoping Plan, May 28, 2008, online at http://www.arb.ca.gov/cc/scopingplan/meetings/5_28notice/presentations/pastor_5_28.pdf.

Researchers at the University of Southern California, Occidental College, and the University of California, Berkeley, have initiated work to assist CARB in these tasks, developing a Cumulative Impact score method to screen for disproportionate air pollution impacts based on (i) hazard proximity and sensitive land uses, (ii) health risk, and (iii) social and health vulnerability.[7] Applying this methodology, the researchers have identified the highest-scoring census tracts in the six-county SCAG (Southern California Association of Governments) area. Socio-demographic data show that these tracts have relatively high percentages of Latinos and African-Americans and relatively low incomes (see Table 2).

Table 2: Socio-Demographic Characteristics (2000) for Tracts with Highest Cumulative Impact Score, 6-County SCAG Area

	Top 6.2% of tracts	Top 12.9% of tracts	Top 20.1% of tracts	SCAG area totals
Total population	924,584	2,035,173	3,270,659	16,479,143
% population	5.6%	12.3%	19.8%	100.0%
% nonwhite	95.4%	92.8%	89.9%	61.2%
% below poverty	33.2%	30.2%	27.9%	15.7%
Median household income	$25,269	$27,533	$29,686	$50,165
Per capita income	$9,221	$10,097	$10,880	$21,101
% black	7.7%	9.2%	10.4%	7.3%
% Hispanic	79.0%	74.5%	69.9%	40.6%
% Asian	7.4%	7.7%	7.8%	10.4%
% other race	1.2%	1.5%	1.8%	2.8%

Source: Unpublished data furnished upon request by Dr. Manuel Pastor, University of Southern California, Program for Environmental & Regional Equity.

Policy Options

The remainder of this memorandum sketches four policies that could be implemented in order to advance the efficiency, environmental, and fairness objectives of AB 32 in relation to co-pollutants: (i) investment by allocating allowance value to a community

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[7] For details, see Manuel Pastor, Jim Sadd and Rachel Morello-Frosch, "Air Quality, Environmental Justice, and Social Vulnerability," presented at the South Coast Air Quality Management District Conference on New Perspectives on Community Health and Air Quality, July 24, 2009. Online at http://www.aqmd.gov/pubinfo/events/communityhealthairqualityconf/PDF/Pastor_AQMDJuly2009.pdf.

benefits fund; (ii) a co-pollutant surcharge; (iii) zonal trading systems; and (iv) priority facility designations.

(i) Investment: Community benefits fund

One way to tackle co-pollutant issues in AB 32 implementation is to allocate some fraction of the revenue from permit auctions to overburdened communities, with the money to be used for environmental improvements.

In its Final Report, the Economic and Technology Advancement Advisory Committee recommended this as one use of auction revenues (which it proposed be routed through a California Carbon Trust):

> *By setting aside a fixed portion of its funds to be distributed to projects based on cumulative impacts, geographic location, demographics, and/or associated co-benefits, this Trust could also help to reach important environmental justice goals. Distributing funds based on geography or demography would ensure that disadvantaged communities receive a pre-determined amount of funding from projects that not only reduce carbon emissions, but also foster community development and protect low income consumers from rising energy prices.[8]*

Issues in developing and implementing a community benefits fund (CBF) policy include:

- how much revenue (or more precisely, the percentage of allowance value) to allocate to CBF;
- which communities are eligible to receive funds;
- what sorts of environmental projects are eligible; and
- what mechanisms should be established to allocate funds across and within communities.

California Assembly Bill 1405, currently being considered in the state legislature, contains specific proposals on these issues. The bill would require that a minimum of 30% of the revenues generated under AB 32 be deposited into the CBF. The bill defines "the most impacted and disadvantaged communities as those areas within each air basin with the highest 10 percent of air pollution impacts, taking into account air pollution exposures and socioeconomic indicators." Within these communities, the CBF would provide competitive grants for projects for purposes such as reducing emissions of greenhouse gases and co-pollutants, minimizing health impacts caused by global warming, and emergency preparedness for extreme weather events caused by global warming.[9]

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[8] *Recommendations of the Economic and Technology Advancement Advisory Committee (ETAAC), Final Report.* February 11, 2008, p 2-5. Online at http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf.

[9] As of this writing, versions of AB 1405 have been passed by the Assembly and two Senate committees. The text is available at http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_1401-1450/ab_1405_bill_20090723_amended_sen_v94.pdf.

The language in AB 1405 provides a reasonable basis for EAAC and CARB to envision how a CBF component might work. In thinking through this prong of a strategy to incorporate co-benefits in policy design, the main issue for EAAC is the appropriate percentage of allowance value to be allocated to this use. For example, a "10-10" formula might allocate 10% of total allowance value to localities with the highest 10% of air pollution impacts.

(ii) Co-pollutant surcharge

A second way to incorporate co-pollutants into AB 32 implementation policy is to levy a surcharge on carbon permits in overburdened jurisdictions, and to dedicate the surcharge revenue to community benefits funds in the same jurisdictions where it is collected.

Attractive features of this option include the following:

- The use of surcharge revenue for this purpose would reduce the need to allocate revenues from carbon permit auctions to CBFs.
- There would be a tight nexus between the fee (surcharge) and its use.
- The surcharge would promote greater emission reductions in places where abatement benefits are greater due to high co-pollutant burdens.
- It affirms the principle that the "sink" functions of air (as a medium for disposal of wastes) belong to the people who breathe it.

To implement such a system, CARB would again identify overburdened locations where the co-pollutant surcharge would be levied, at the time of carbon permit surrender in the case of stationary sources or and the time of fuel delivery in the case of residential and mobile sources. By increasing the price of fossil fuels above what it would be in the absence of the surcharge, this would provide an incentive for greater emissions reductions in these locations. The revenue from the surcharge would then be allocated to CBFs in the same locations.

(iii) Zonal trading systems

A third way to include co-benefits from co-pollutant reductions in cap-and-trade policy design is to establish "zones" to guarantee some minimum level of emissions reductions in high-priority locations where co-benefits are greatest. Such areas may be identified using the methodology currently being developed by CARB.

In zonal trading systems, the availability of permits is defined on a zone-by-zone basis, i.e., permits are allocated across zones within the overall cap. Zone-based "sub-caps" can be established regardless of whether permits are distributed via auction, free allowances, or some combination of the two. The zones create semi-permeable boundaries for permit

trading: polluters in lower-priority zones can buy permits from polluters in higher-priority zones, but permit trades against this gradient are not allowed.

Similarly, the purchase of offsets is constrained or proscribed altogether in high-priority zones. In the presence of co-pollutants, the purchase of offsets from out-of-state has the effect of exporting the co-benefits from air quality improvements.[10] In the same way, offsets would result in the loss of co-benefits from co-pollutant reduction in high-priority zones.

A zonal system need not be restricted to point-source emissions: it could be applied to mobile sources as well. Just as AB 32 effectively makes the state of California into a "zone" where carbon emissions from both point sources and mobile sources can be capped differentially from other states, so a zonal system can differentiate across regions and/or localities within the state.

One precedent for a zonal trading system is California's Regional Clean Air Incentives Market (RECLAIM), launched in 1994 to reduce point-source emissions of nitrogen oxides and sulfur oxides in the Los Angeles basin. The South Coast Air Quality Management District established two zones under RECLAIM: zone 1, the coastal zone, where pollution is more severe and the benefits from pollution reduction are considered to be greater; and zone 2, the inland zone, where pollution is less severe. Facilities in zone 1 can buy permits only from other facilities in the same zone; facilities in zone 2 can buy permits from either zone. One impact of the RECLAIM zonal trading system is that average permit prices have been roughly eight times higher in zone 1 than in zone 2.[11]

In the absence of regionally variable co-pollutant intensity, these permit price differentials across zones would be a symptom of inefficiency. If marginal abatement benefits were equal across pollution sources, the efficiency criterion would call for equalization of marginal abatement costs as well. But as noted above, co-pollutants result in variations in marginal abatement benefits, and for this reason, permit price differentials can be an efficiency-improving result.

A zonal trading system – whether comprising two zones as in RECLAIM, or several zones – cannot, of course, perfectly match marginal abatement costs to all variations across pollution sources in marginal abatement benefits. Within any zone, some variations will persist. But the question is not whether a zonal trading system yields textbook efficiency; it is whether it yields a better outcome in terms of environmental, efficiency, and equity criteria than a system without zones. When externalities are spatially differentiated – that is, when emission location matters – zonal trading systems

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[10] David Roland-Holst, "Carbon Emission Offsets and Criteria Pollutants: A California Assessment," University of California Berkeley, Center for Energy, Resources, and Economic Sustainability, Research Paper No. 0903091, March 2009.

[11] Lata Gangadharan, "Analysis of prices in tradable emission markets: An empirical study of the Regional Clean Air Incentives Market in Los Angeles," *Applied Economics* 36: 1569-1582, 2004.

can be a "second-best" solution that yields a better outcome than the no-zone alternative.[12]

(iv) Priority facility designations

A fourth option is to identify specific facilities that emit very high levels of co-pollutants and/or make the most significant contributions to co-pollutant burdens in disadvantaged communities, and to designate these as priority facilities for carbon emission reductions.[13] Again, such facilities may be identified using methodology currently being developed by CARB.

Similar to zonal trading systems, within the overall cap the priority facilities designation would establish facility-specific "sub-caps" on the number of permits available to these facilities. Again, the policy would create a semi-permeable boundary: other polluters can buy permits from designated priority facilities, but not vice versa. Similarly, the purchase of offsets by priority facilities would be constrained or proscribed.

This policy option takes advantage of the common phenomenon of "disproportionality" in environmental impacts: a few facilities with much higher than average impacts often account for a large fraction of the total impact.[14] By targeting a relatively small number of facilities that account for a relatively large share of co-pollutant damages in disadvantaged communities, this policy could achieve a large payoff while economizing on administrative burdens.

Concluding remarks

Policies to reduce carbon-dioxide emissions from burning fossil fuels generate co-benefits – above and beyond the climate-change benefits – by reducing emissions of co-pollutants that harm human health. Valuation studies suggest that these co-benefits are comparable in magnitude to the benefits of carbon-dioxide emission reductions alone.

Damages from co-pollutants per unit carbon-dioxide emissions vary across locations and pollution sources. Historically overburdened communities tend to be economically and socially disadvantaged in other respects as well.

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[12] Tom Tietenberg, "Tradeable permits for pollution control when emission location matters: What have we learned?" *Environmental and Resource Economics* 5: 95-113, 1995.

[13] The significance of plant-to-plant variations in co-pollutant intensity also is underscored in the National Academy of Sciences study. See the comments of Professor Maureen Cropper, vice-chair of the NAS committee that produced the study, in *The New York Times,* October 20, 2009: http://www.nytimes.com/2009/10/20/science/earth/20fossil.html.

[14] For discussion, see Lisa M. Berry, "Inequality in the Creation of Environmental Harm: Looking for Answers from Within," in Robert C. Wilkinson and William R. Freudenberg, eds., *Equity and the Environment: Research in Social Problems and Public Policy, Volume 15.* Amsterdam: Elsevier, 2008.

Hence the efficiency, environmental, and fairness objectives of AB 32 can be furthered by policies that take co-pollutants and co-benefits into account.

This memorandum has sketched four policy options:

(i)   allocating some fraction of allowance value to community benefits funds (CBFs);

(ii)   introducing a co-pollutant surcharge, with the proceeds dedicated to CBFs;

(iii)   establishing a zonal trading system that restricts the ability of polluters in high-priority localities from "buying out" of emission-reduction obligations by purchasing offsets or permits from other localities; and

(iv)   designate priority facilities for co-pollutant reductions, with restrictions on their ability to purchase offsets or permits from other polluters.

These four options are not mutually exclusive. Rather they can be regarded as complementary instruments to advance the same goal: incorporating co-pollutants and the co-benefits from their reduction into climate policy design.

APPENDIX: CAP-AND-DIVIDEND

James K. Boyce

This appendix discusses the return of carbon permit auction revenues as equal per capita dividends to the public, a policy sometimes termed "cap-and-dividend." It covers five issues: (i) rationales; (ii) precedents; (iii) distributional impacts; (iv) criticisms; and (v) taxability of dividends.

Rationales

There are three fundamental rationales for cap-and-dividend:

1. *The principle of common ownership of nature's wealth:* A consequence of any policy to limit use of a resource – to manage scarcity – is the creation of property rights. Cap-and-dividend starts from the premise that rights to the property created by the introduction of carbon permits belong in common and equal measure to all.[15] Cap-and-dividend is akin to a "feebate" arrangement in which individuals pay fees based on their use of a scarce resource that they own in common, and the fees are then rebated in equal measure to all co-owners. In this case, the scarce resource is the California's share of the carbon storage capacity of the atmosphere; the fee is set by the carbon footprint of each household; and the co-owners are the people of the state.

2. *Protection of household real incomes:* A second rationale is to protect the real incomes of households from the impact of higher fossil fuel prices resulting from the cap. The motivation here is similar to others under the heading of compensation. If the amount paid by households in higher prices is returned as dividends, the household sector as a whole is "made whole" by the policy. The net impact on any individual household varies depending on its carbon footprint. Those with larger-than-average carbon footprints pay more than they receive in dividends; those with smaller-than-average carbon footprints receive more than they pay. Since carbon footprints are correlated with income, lower-income and middle-income families generally receive greater net benefits from the policy than upper-income households. Across the entire income spectrum, however, every

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[15] To clarify: Carbon permits themselves are not property rights. Just as buying a parking permit is not the same as owning the parking lot, buying a carbon permit is not the same as owning the property created by a carbon cap. A carbon permit allows the holder to "park" carbon in the atmosphere. The property may be owned by the government (if permits are auctioned and the revenue is used by the state); by firms (if they receive free permit allocations); or by the people (if permits are auctioned and the revenue is returned to the public).

household has an incentive to reduce its carbon footprint in response to market price signals: those who reduce them most obtain the greatest net monetary gain.

3. *Securing durable public support for the carbon policy:* A cap on carbon emissions will increase the prices of gasoline, electricity, and other commodities in proportion to their carbon content. A cap that does not have this effect is not a binding cap. For political sustainability, it is important to anticipate public reactions to higher fuel prices and to craft a policy design that voters will accept or, better yet, positively welcome. Cap-and-dividend's democratic premise – that California's share of the atmosphere's carbon-absorptive capacity belongs to its people – and its visible contribution to family incomes may improve the carbon policy's prospects for survival over the long haul.

Precedents

Two precedents for a cap-and-dividend policy are the Alaska Permanent Fund, which distributes dividends from oil revenues equally to all residents of that state, and the "Climate Change Consumer Refund Account" provision of the American Clean Energy and Security Act (ACES, also known as the Waxman-Markey bill) now before Congress.

The *Alaska Permanent Fund,* established in 1976 under the leadership of Governor Jay Hammond, recycles oil-extraction royalties to the public as equal per-person dividends. Last year the dividend per capita amounted to $2,069 (in addition to a one-time "resource rebate" of $1,200). Apart from operationalizing the core principle of common and equal ownership of natural wealth, the Fund demonstrates that it is administratively feasible for state governments to define eligibility and disburse dividends to residents. A major difference, of course, is that the Alaska Permanent Fund gives residents an incentive to support higher oil extraction, whereas cap-and-dividend results in the opposite incentive: a tighter cap yields increased dividends (assuming inelastic demand for fossil fuels, i.e., a 10% increase in prices is associated with a less-than-10% reduction in demand, and hence higher total revenue).

The *Climate Change Consumer Refund Account* that is proposed in section 789(a) of the ACES bill provides that:

> *In each year after deposits are made to the Climate Change Consumer Refund Account, the Secretary of the Treasury shall provide tax refunds on a per capita basis to each household in the United States that shall collectively equal the amount deposited into the Climate Change Consumer Refund Account.*

The share of the Climate Change Refund Account in the proposed allocation of allowance value in ACES over time is shown in Figure 1. The refund, depicted by the green area in the top layer of the graph, begins in the 2020s and grows to about 50% of allowance value in the 2030s and 2040s. While ACES is not a cap-and-dividend policy in its initial years, it substantially turns into one over time.

Figure 1: Distribution of Allowances Proposed in ACES
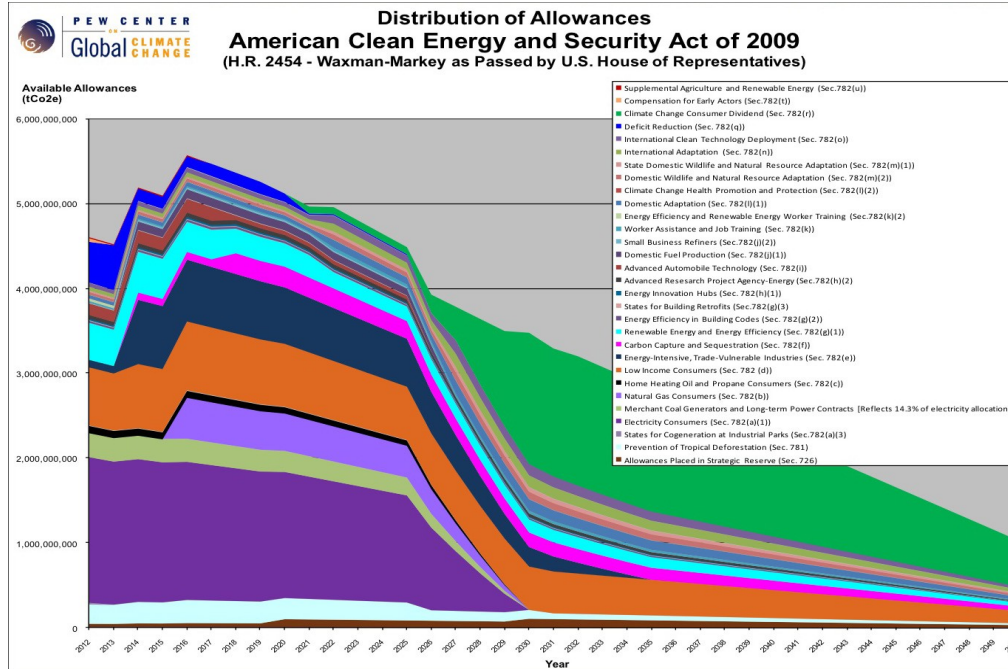
Source: "Federal Climate Change Policy: Allowance Distribution," presentation of Judi Greenwald to the EAAC, July 1, 2009. Available at http://www.climatechange.ca.gov/eaac/meetings/2009-07-01/documents/Presentation_Judi_Greenwald_Waxman-Markey_Allocation.pdf.

Distributional impacts

The gross cost to a household from carbon pricing is a function of the amount of fossil carbon embodied in the production and distribution of the goods and services it consumes (the household's "carbon footprint"). The breakdown across expenditure categories for the median California household is shown in Figure 2.[16]

Because lower-income households generally consume less than higher-income households, they typically have smaller carbon footprints. Differences across income brackets in California are shown in Figure 3. In the highest decile, carbon emissions per capita are roughly six times greater than in the lowest decile.

As a *share* of their income, however, the poor consume more carbon than the rich – that is, more carbon per dollar – as shown in Figure 4. This is largely because fuels and electricity account for a larger share of their household budgets, whereas upper-income groups spend a higher share on other items. In the absence of offsetting transfers of

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[16] Based on data from the 2003 Consumer Expenditure Survey, the 2003 Input-Output Tables and the 2002 Benchmark Input-Output Tables. Source: James K. Boyce and Matthew E. Riddle, "Cap and Dividend: A State-by-State Analysis," Amherst, MA: Political Economy Research Institute and Portland, OR: Economics for Equity and the Environment Network, August 2009, Figure 3. Available at http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/CAP_DIVIDEND_states.pdf.

allowance value, putting a price on carbon therefore is regressive: the higher prices arising from the introduction of carbon permits takes a larger share of income from the poor than from households in upper-income brackets.

**Figure 2: Carbon Footprint by Expenditure Category: Median CA Household**

electricity
12%

heating oil
1%

natural gas
9%

indirect
43%

gasoline
35%
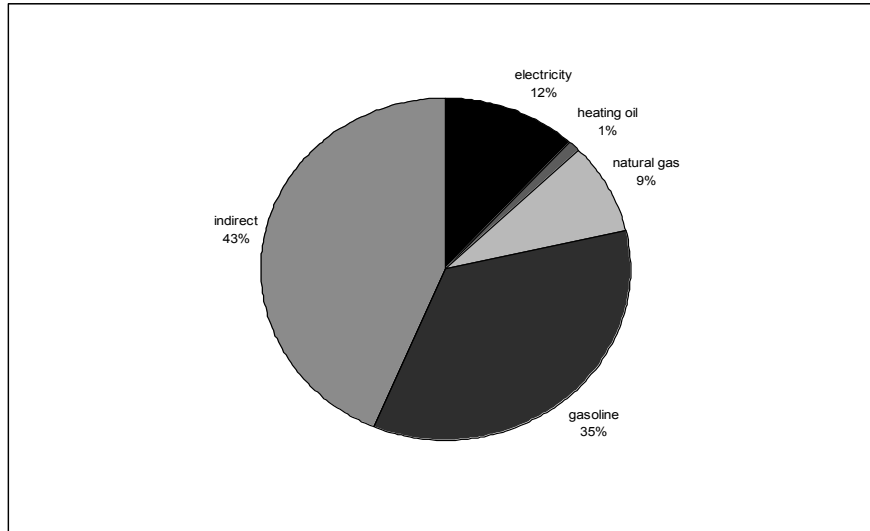
Source: Calculated using the methodology of Boyce and Riddle (2009).

Figure 3: Carbon Footprint by Income Decile in California
(metric tons CO_2 per capita)

Household carbon footprint by income decile (metric tons CO_2 per capita)
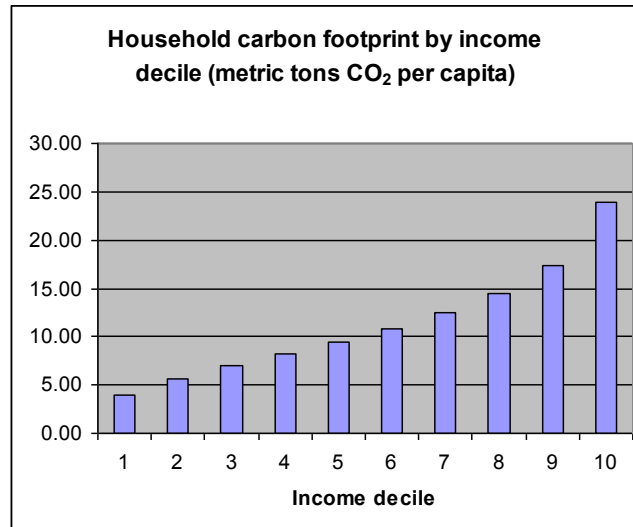
Source: Calculated using the methodology of Boyce and Riddle (2009).

Figure 4: Carbon Footprint by Income Decile in California
(kg CO$_2$ per dollar)
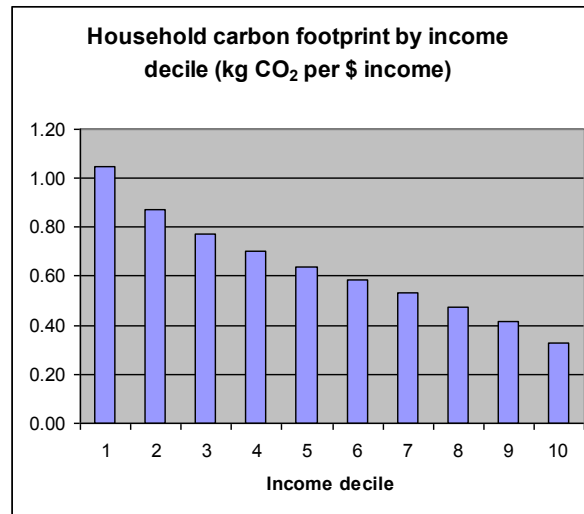
Source: Calculated using the methodology of Boyce and Riddle (2009).

Table 1: Impact of National Cap-and-Dividend Policy on California Households by Income Decile

($25/tCO$_2$; 100% auction; 80% of revenue distributed as dividends)

Per capita income decile	Per capita income	$ per capita			% of income		
		Carbon charge	Dividend	Net impact	Carbon charge	Dividend	Net impact
1	3788	108	386	278	2.9%	10.2%	7.3%
2	6545	149	386	237	2.2%	5.9%	3.6%
3	9062	179	386	207	1.9%	4.3%	2.3%
4	11752	207	386	179	1.7%	3.3%	1.5%
5	14841	236	386	150	1.5%	2.6%	1.0%
6	18603	268	386	118	1.4%	2.1%	0.6%
7	23494	305	386	81	1.2%	1.6%	0.3%
8	30469	354	386	32	1.1%	1.3%	0.1%
9	42186	426	386	-40	0.9%	0.9%	-0.1%
10	72895	593	386	-207	0.8%	0.5%	-0.3%

Source: Boyce and Riddle (2009, Tables 3, 4, 5 & A.1).

Because gross costs to households are based on their carbon footprints, while dividends are paid equally to all, the *net impact* of cap-and-dividend is distributionally progressive. Table 1 illustrates this point, showing how California households would be affected by a national cap-and-dividend policy with a permit price of $25/ton carbon dioxide, 100% of permits auctioned, and 80% of auction revenue returned as dividends. In this scenario, lower-income deciles see substantial net benefits; middle-income deciles are "kept whole" with dividends more than offsetting the impact of higher fuel prices; and the top

two deciles see net costs. Overall, roughly eight in ten California households come out ahead in monetary terms – without counting the environmental benefits that are the carbon policy's main objective.

A California-only cap-and-dividend policy will yield somewhat different numbers than a national policy, even with the same carbon price and same revenue-allocation parameters, among other reasons because (i) the carbon footprint of the average California resident is below the national average, largely due to energy efficiency policies that have reduced per capita electricity consumption, so Californians fare better than average in a nationwide policy; and (ii) imports and exports (at the state level, i.e. from/to out-of-state) account for a bigger fraction of consumption and carbon emissions, respectively, than at the national level. All else equal, the former would result in lower net benefits than those reported in Table 1, while the latter would result in higher net benefits. But the broad pattern would persist: lower-income households gain, the middle class is protected, and upper-income groups bear a net cost.

Outcomes for individual households could differ from these broad patterns. In any income bracket, those who respond more strongly to the market price signals produced by the cap will fare better than those who do not curb consumption of fossil fuels. Upper-income households with carbon footprints below the norm for their bracket could get positive net benefits; lower and middle-income households with disproportionately large carbon footprints could come out behind.

Criticisms

Criticisms of dividends fall into three classes: (i) other priorities for revenue (or allowance value) allocation; (ii) universal coverage versus targeted beneficiaries; and (iii) regional disparities.

1. *Other priorities* include all non-dividend allocations of allowance value whether via free permits or auction revenue uses. Some of these are transitional in nature: compensation and at least some investment functions are in this category. Some are more permanent: general government revenue (and tax-shifting with the potential "double-dividend" efficiency gains) is in this category. In the case of transitional priorities, the policy mix between dividend and non-dividend allocations could change over time with the share allocated to dividends gradually increasing, as in ACES.

2. *Universal coverage* is sometimes criticized on the grounds that dividends would be received by people who "don't need them." The Center for Budget and Policy Priorities has proposed instead that dividends be targeted to low-income households.[17] The provision for refunds to low-income consumers in ACES

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[17] Robert Greenstein *et al.,* "Designing Climate-Change Legislation that Shields Low-Income Households from Increased Poverty and Hardship," Washington, DC: Center for Budget and Policy Priorities, May 9, 2008. Available at http://www.cbpp.org/files/10-25-07climate.pdf.

(Section 782(d)) embodies this approach. Targeted payments may be viewed as an adequate response to the compensation rationale for dividends. But they do not respond to the common ownership rationale. In addition, universal coverage may have political appeal; witness the durable public support for Social Security. Means-testing also would impose the extra administrative costs.

3. *Regional disparities* result from cap-and-dividend when carbon footprints differ by location. At the national level, inter-state disparities in net impact are modest, and much smaller than those of many other federal policies including defense spending and farm programs.[18] Within California, differences in the carbon-intensity of the electricity supply would contribute to regional disparities, but these are modest since electricity accounts for only 12% of the median household's carbon footprint (see Figure 1). Any regional disparities arise from carbon pricing – not from dividends – so they are equally relevant for other policies on allocation of allowance value.

Taxability of dividends

The taxability of dividends may affect decisions regarding the share of allowance value to be allocated to this purpose: if dividends are taxable, a fraction of the allowance value flows back to government, becoming available other uses; if they are non-taxable, a larger share of allowance value is needed for non-dividend uses to obtain the equivalent result.

One argument in favor of taxable dividends is that governments (local, state, and federal) will be impacted by higher fuel prices, as well as consumers. Nationwide, government consumption accounts for about 19% of carbon emissions: the federal government accounts for 6.5%, state and local governments for the other 12.5%.[19] To protect government purchasing power or "keep government whole," a return flow of carbon revenue is needed.

Because income taxation is progressive, larger taxable dividends are preferable on equity grounds to smaller non-taxable dividends with equal government revenue. Compared to taxable dividends, taking the government's share "off the top" by reducing dividends is equivalent to a head tax: it would take an equal dollar amount from each person regardless of income level, and hence would be regressive.

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[18] Boyce and Riddle (2009), Figure 6.

[19] James K. Boyce and Matthew Riddle, "Keeping the Government Whole: The Impact of a Cap-and-Dividend Policy for Curbing Global Warming on Government Revenue and Expenditure," Amherst, MA: Political Economy Research Institute, Working Paper No. 188, November 2008, Table 1. Available at http://www.peri.umass.edu/fileadmin/pdf/working_papers/working_papers_151-200/WP188.pdf.

APPENDIX – Market Barriers to Deploying Clean Energy Technologies (ETAAC)
(submitted

Potential Barriers to the Commercialization and Deployment of Low and Zero Greenhouse Gas Technologies		
Cost and Market Barriers		
External Benefits	Frequency- **high** Severity- **high**, in some cases considered medium	External benefits of GHG-reducing technologies that are not available to the owners of the technologies, as well as other environmental benefits and employment & other spill-over economic benefits are examples.
Up-Front Capital Costs	Frequency – **high** Severity - **high**	Up-front capital costs are higher for the production and purchase of many zero and low-carbon technologies. While capital costs are often repaid over time, lack of access to capital and short term planning by industries, small businesses, and households can compound this barrier. Capital-intensive demonstrations may be particularly challenging.
Demonstration Costs & Risks	Frequency – **high**/med Severity- **high**/med	Technologies in the development & demonstration phase may have higher capital cost, higher labor/operating cost, increased downtime & lower reliability, lack of standardization, and/or lack of engineering, procurement and construction capacity. Private investments in reducing this costs & risks through demonstration projects may be disincentivized by benefits that can be shared by competitors.
Market Demand	Frequency – med/**high** Severity- med/**high**	Customers may be risk/change-adverse; "chicken and egg" dilemma of low demand for emerging technologies prior to full commercialization may inhibit production at scale necessary to achieve full commercialization.
Misplaced Incentives	Frequency- medium Severity-medium (in some cases considered low or high)	Misplaced incentives occur when the buyer/owner is not the consumer/user (e.g., landlords and tenants in the rental market and speculative construction in the buildings industry) – also known as the principal-agent problem.
Information Barriers		
Incomplete and Imperfect Information	Frequency- **high**/med Severity- med/**high**	Lack of information about technology performance (especially trusted information), increased decision-making complexities, and cost of gathering and processing information about new technologies are potential barriers. This barrier may be compounded to the extent that shared benefits of customer education are a distinctive for private investments.
Lack of Specialized Knowledge	Frequency – med/**high** Severity- in some cases considered low, med, and **high**	Inadequate workforce training/expertise, cost of developing a knowledge base for available workforce, and inadequate reference knowledge for decision makers are examples.
Categories developed from Oak Ridge National Laboratory Report "Carbon Lock-in, Barriers to Deploying Climate Change Mitigation Technologies", Dr. Marilyn Brown et. al as revised January 2008; February 2008 ETAAC report; ETAAC April & June 2009 meetings		

ETAAC Review of Potential Barriers to the Commercialization and Deployment of Low and Zero Greenhouse Gas Technologies		
Government Barriers		
Unfavorable Standards	Frequency- med Severity- med (in some cases considered **high**)	Standards that "grandfather" existing infrastructure and facilities; programs that operate in "silos" rather than integrating relevant concerns such as air quality, climate change, and energy security; and rules granting access to water rights and other resources on a "first come first served" basis can create barriers.
Uncertain Standards	Frequency – med Severity- med	Examples of uncertainty about future regulations of greenhouse gases including emission levels, potential GHG emission subsidies through free GHG allowances allocations, and ownership/liability of underground sequestered carbon.
Unfavorable Fiscal Policy	Frequency – med Severity – med (in some cases considered low)	Fiscal policies that slow the pace of capital stock turnover; state and local variability in fiscal policies such as tax incentives and property tax policies; distortionary tax subsidies that favor conventional energy sources and high levels of energy consumption are potential barriers.
Uncertain Fiscal Policy	Frequency – med (in some cases considered **high**) Severity- med (in some cases considered **high**)	Short-duration tax & fiscal policies (such as production tax credits); uncertainty over future costs for GHG emissions; market-development oriented incentive programs with uncertain lifespan & funding levels are examples.
Unfavorable Approval Processes	Frequency – med Severity – **high** (in some cases considered med)	Approval processes may favor incumbents if agencies lack familiarity & established processes for new technologies such as carbon capture and sequestration and off-shore energy development. Permitting/approval procedures serving valuable public purposes that apply to new but not existing facilities & infrastructure may favor incumbents that are grandfathered, especially when approval processes are not coordinated.
Uncertain Approval Processes	Frequency – med Severity – med/**high**	Uncertain timing and outcome of approval processes may be a potential barrier.

ETAAC Review of Potential Barriers to the Commercialization and Deployment of Low and Zero Greenhouse Gas Technologies		
Industry Structure & Infrastructure Barriers		
Existing Infrastructure "Lock-in"	Frequency- med/**high** (even split) Severity- med/**high** (even split)	Existing large investments such as long-term power and transportation fuels production and distribution infrastructure can "lock-in" existing technologies.
Lack of Needed Infrastructure for New Technology	Frequency – **high**/med Severity-**high**	Renewable electricity transmission capacity, alternative transportation energy supply distribution, and other infrastructure needs are examples. Lack of manufacturing facilities and distribution/supply channels and other supply chain shortfalls can also be a barrier.
Incumbent Industry Market Dominance	Frequency- **high** , in some cases considered low and med Severity-mostly **high,** in some cases considered low	Natural monopolies or large incumbents with market power may disenable technological innovation to prevent disruption of existing profitable markets & investments.
Industry Segmentation or Fragmentation	Frequency- med Severity- med/low	Industry segmentation can inhibit change. For instance, manufacturing a single long-haul truck is often split among independent engine, chassis, and body manufacturers segments, with a variety of manufacturers within each segment. Small business owners may be harder to reach with information about new energy efficiency technologies, especially as their needs often vary based on business type.
Intellectual Property	Frequency-med Severity-low/med	High transaction costs for patent filing and enforcement, conflicting views of a patent's value, and techniques such as patent warehousing, suppression, and blocking can create barriers.